SINGLE-IMPACT FICHE
LANDSCAPE FEATURES

IMPACT: POLLINATION

Data extracted in May 2022
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Note to the reader: This fiche summarises the effects of Landscape features on POLLINATION. It is based on 8 synthesis papers[1], including from 29 to 121 primary studies.

1. WEIGHT OF THE EVIDENCE

CONSISTENCY OF THE IMPACT

The effect on pollination differs among landscape features.

The table below shows the number of synthesis papers with statistical tests reporting i) a significant difference between the Intervention and the Comparator, that is to say, a significant statistical effect, which can be positive or negative; or ii) a non-statistically significant difference between the Intervention and the Comparator. In addition, we include, if any, the number of synthesis papers reporting relevant results but without statistical test of the effects. Details on the quality assessment of the synthesis papers can be found in the methodology section of this WIKI.

- Landscape features in general (measured as percentage of natural area) have a significantly positive effect on pollination (i.e. increase of pollination) and the abundance and richness of some pollinator taxa compared to agricultural lands with lower percentage of natural area, according to 2 synthesis papers. While 1 of these papers also reports a non-significant effect on the abundance and richness of other pollinator taxa.
- Field margins have a significantly positive effect on pollination compared to cropland or grassland without field margins, according to 3 synthesis papers.
- Flower strips have a significantly positive effect on local pollinator abundance compared to cropland or grassland without flower strips and in the abundance and richness of pollinators in the flower strips themselves, according to 3 synthesis papers. While flower strips have a non-significant effect on pollinators abundance and pollination services in the crops, according to 3 synthesis papers.
- Hedgerows have a non-significant effect on crop pollination compared to cropland without hedgerows, according to 1 synthesis paper.

All selected synthesis papers included studies conducted in Europe (see **Table 2**).

Table 1: Summary of effects. Number of synthesis papers reporting positive, negative or non-statistically significant effects on environmental and climate impacts. The number of synthesis papers reporting relevant results but without statistical test of the effects are also provided. When not all the synthesis papers reporting an effect are of high quality, the number of synthesis papers with a quality score of at least 50% is indicated in parentheses. The reference numbers of the synthesis papers reporting each of the effects are provided in **Table 3**. Some synthesis papers may report effects for more than one impact or more than one effect for the same impact.

				Statistically tested			Non-statistically tested
Impact	Metric	Intervention	Comparator	Significantly positive	Significantly negative	Non-significant	
Increase pollination	Pollination	Field margins	No field margins	3	0	0	0
		Flower strips	No flower strips	3	0	3	0
		Hedgerows	No hedgerows	0	0	1	0
		Landscape features in general	No semi-natural habitat features	2	0	1	0

QUALITY OF THE SYNTHESIS PAPERS

The quality of each synthesis paper was assessed based on 16 criteria regarding three main aspects: 1) the literature search strategy and primary studies selection; 2) the statistical analysis conducted; and 3) the evaluation of potential bias. We assessed whether authors addressed and reported these criteria. Then, a quality score was calculated as the percentage of these 16 criteria properly addressed and reported in each synthesis paper. Details on quality criteria can be found in the methodology section of this WIKI.

2. IMPACTS

[1] Synthesis research papers include either meta-analysis or systematic reviews with quantitative results. Details can be found in the methodology section of the WIKI.

The main characteristics and results of the 8 synthesis papers are reported in **Table 2** with the terminology used in those papers, while **Table 3** shows the reference numbers of the synthesis papers reporting for each of the results shown in **Table 1**. Comprehensive information about the results reported in each synthesis paper, in particular about the modulation of effects by factors related to soil, climate and management practices, are provided in the **summaries of the synthesis papers** available in this WIKI.

Table 2: Main characteristics of the synthesis papers reporting effects on pollination. The references are ordered chronologically with the most recent publication date first.

Reference number	Population	Scale	Num. papers	Intervention	Comparator	Metric	Conclusion	Quality score
Ref2	Arable crops, vegetables and orchards in Europe, America, New Zealand and South Africa	Global	29	Field-edge flower plantings	Unplanted, unmanaged field edges; unplanted, managed field edges (e.g., herbicide or mowing); grass strips; bare ground; and crop fields with no edge	Pollinator abundance and richness in the field-edge flower plantings; Pollinator abundance and richness in the crops	Results suggest that field-edge flower plantings are highly effective at increasing pollinator richness and abundance in field edges and that plantings become more effective as they mature. However, the influence of field-edge plantings on crop pollination is inconsistent.	88%
Ref5	Cropland	North America, Europe, New Zeland	35	1) Flower strips; 2) Hedgerows	1) No flower strips; 2) No Hedgerows	Crop pollination service	This synthesis reveals inconsistent and highly variable effects of flower strips and hedgerows on crop pollination services.	62%
Ref10	Croplands and grasslands	Northern hemisphere	40	Sites with field margin floral enhancement	Sites without field margin floral enhancement	Abundance and richness of pollinators	Overall, the field margin floral enhancements increased the abundance and richness of pollinators at the field edge but had no consistent effect in the interior of the crop fields.	81%
Ref13	Croplands and grasslands	Europe	62	Agri-environmental management schemes (hedges, field margins and set aside lands)	No agri-environmental management schemes (usually conventional farming)	Pollinators species richness	This study shows that pollinator species richness benefitted from agri-environmental management schemes.	81%
Ref15	Agroecosystems	Global	43	High landscape complexity (proportion of non-crop area)	Low landscape complexity (proportion of non-crop area)	Abundance of 1) solitary bees; 2) above-ground nesting bees; 3) below-ground nesting bees; 4) large bees; 5) small bees; Richness of: 6) solitary bees; 7) above-ground nesting bees; 8) small bees	The proportion of non-crop area was positively associated with the abundance and richness of solitary bees and was no related with the other traits.	81%
Ref16	Terrestrial landscapes in rural, agricultural, mixed rural–urban or natural habitats regions	Global	121	High landscape complexity (percentage of natural area)	Low landscape complexity (percentage of natural area)	Pollination (abundance, richness, diversity, and effects of pollinators)	The percentage of natural areas had an effect on pollination (E++ = 0.41). The meta-analyses reinforce the importance of considering landscape structure in assessing ecosystem services for management purposes and decision-making.	81%
Ref26	Croplands and grasslands	Europe	71	Sites with agrienvironmental measures including 1) sown flower strip; 2) grass-sown or naturally regenerated field margin or set-aside)	Conventionally managed control sites	Abundance and richness of pollinators	This study shows that agri-environmental measures generally enhance local pollinator species richness and abundance in agroecosystems.	69%
Ref27	Fields, orchards, and vineyards of food crops	Global	46	High compositional complexity (landscape complexity: proximity or proportion of non-crop or natural habitats in the landscapes surrounding food crops; or local complexity: proximity or diversity of non-crop plants in margins of food crops)	Low compositional complexity	Abundance and richness of pollinators	Some pollinators and natural enemies seem to have compatible responses to complexity, and it might be possible to manage agroecosystems for the benefit of both.	81%

Table 3: Reference numbers of the synthesis papers reporting for each of the results shown in **Table 1**.

				Statistically tested			Non-statistically tested
Impact	Metric	Intervention	Comparator	Significantly positive	Significantly negative	Non-significant	
Increase pollination	Pollination	Field margins	No field margins	Ref13, Ref26 and Ref27			
		Flower strips	No flower strips	Ref2, Ref10 and Ref26		Ref2, Ref5 and Ref10	
		Hedgerows	No hedgerows			Ref5	
		Landscape features in general	No semi-natural habitat features	Ref15 and Ref16		Ref15	

3. FACTORS INFLUENCING THE EFFECTS ON POLLINATION

Table 4: List of factors reported to significantly affect the size and/or direction of the effects on pollination, according to the synthesis papers reviewed.

Factor	Reference number

Factor	Reference number
Distance to field edge	Ref5
Ecological contrast (difference in richness of plant communities between field margins and crop)	Ref13
Field edge management	Ref10
Field edge vegetation type	Ref10
Flowering plant species richness	Ref5
Landscape structure (proportion of semi-natural habitats)	Ref13
Number of flower species in strip	Ref26
Pollinator species	Ref10
Time since treatment	Ref5

4. KNOWLEDGE GAPS

Table 5: Knowledge gap(s) reported by the authors of the synthesis papers included in this review.

Ref Num	Gap
Ref2	Critical gaps in our knowledge of when and how plantings can improve ecosystem service provision and delivery. Determining if field-edge plantings affect pollinator population growth may clarify how plantings improve crop pollination, while further research on landscape context and crop type may define when this happens.
Ref10	Authors detected a bias in publications studying the impact of field margins on biodiversity at the edge of the crop primarily with positive effect sizes and larger standard errors (i.e. low sample size).
Ref13	There was a geographical bias in the dataset, as most studies originated from Western or Northern Europe.
Ref27	The authors identified the interactions between pollinators and natural enemies and their interacting effects on crop productivity as knowledge gaps.

5. SYNTHESIS PAPERS INCLUDED IN THE REVIEW

Table 6: List of synthesis papers included in this review. More details can be found in the summaries of the meta-analyses.

Ref Num	Author(s)	Year	Title	Journal	DOI
Ref2	Lowe, EB; Groves, R; Gratton, C	2021	Impacts of field-edge flower plantings on pollinator conservation and ecosystem service delivery - A meta-analysis	AGRICULTURE ECOSYSTEMS AND ENVIRONMENT, 310, 107290.	10.1016/j.agee.2020.107290
Ref5	Albrecht, M; Kleijn, D; Williams, NM; Tschumi, M; Blaauw, BR; Bommarco, R; Campbell, AJ; Dainese, M; Drummond, FA; Entling, MH; Ganser, D	2020	The effectiveness of flower strips and hedgerows on pest control, pollination services and crop yield: a quantitative synthesis	ECOLOGY LETTERS, 23(10), 1488-1498.	10.1111/ele.13576
Ref10	Zamorano, J; Bartomeus, I; Grez, AA; Garibaldi, LA	2020	Field margin floral enhancements increase pollinator diversity at the field edge but show no consistent spillover into the crop field: a meta-analysis	INSECT CONSERVATION AND DIVERSITY, 13, 519-531.	10.1111/icad.12454
Ref13	Marja, R; Kleijn, D; Tscharntke, T; Klein, AM; Frank, T; Batáry, P	2019	Effectiveness of agri-environmental management on pollinators is moderated more by ecological contrast than by landscape structure or land-use intensity	ECOLOGY LETTERS, 22, 1493-1500.	10.1111/ele.13339
Ref15	Coutinho, JGD; Garibaldi, LA; Viana, BF	2018	The influence of local and landscape scale on single response traits in bees: A meta-analysis	AGRICULTURE, ECOSYSTEMS AND ENVIRONMENT, 256, 61-73.	10.1016/j.agee.2017.12.025
Ref16	Duarte, GT; Santos, PM; Cornelissen, TG; Ribeiro, MC; Paglia, AP	2018	The effects of landscape patterns on ecosystem services: meta-analyses of landscape services	LANDSCAPE ECOLOGY, 33(8), 1247-1257.	10.1007/s10980-018-0673-5
Ref26	Scheper, J; Holzschuh, A; Kuussaari, M; Potts, SG; Rundlf, M; Smith, HG; Kleijn, D	2013	Environmental factors driving the effectiveness of European agri-environmental measures in mitigating pollinator loss – a meta-analysis	ECOLOGY LETTERS, 16(7), 912-20.	10.1111/ele.12128
Ref27	Shackelford, G; Steward, PR; Benton, TG; Kunin, WE; Potts, SG; Biesmeijer, JC; Sait, SM	2013	Comparison of pollinators and natural enemies. A meta-analysis of landscape and local effects on abundance and richness in crops	BIOLOGICAL REVIEWS, 88(4), 1002-1021.	10.1111/brv.12040

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